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NATIONAL AERONAUTICS
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SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15627

RECIPROCATING WATER CHILLERS

12/03

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 GENERAL REQUIREMENTS
1.3.1 Mechanical
1.3.2 Electrical

PART 2 PRODUCTS

2.1 MANUFACTURED CHILLER UNIT
2.2 LIQUID CHILLER
2.3 COMPONENTS
2.3.1 Compressor
2.3.1.1 Lubricating System
2.3.1.2 Capacity-Reduction
2.3.1.3 Motor
2.3.1.4 Crankcase Heater
2.3.2 Condenser
2.3.3 Evaporator
2.4 ACCESSORIES
2.4.1 Refrigerant Circuit
2.4.2 Control
2.4.2.1 Sequence Panel
2.4.2.2 Control Panel
2.4.2.3 Operating Controls
2.4.3 Alarm Package
2.4.4 Hot Gas Bypass
2.4.5 Gage Board
2.4.6 Vibration Isolators

PART 3 EXECUTION

3.1 INSTALLATION
3.2 MANUFACTURER'S FIELD SERVICE

3.3 DEMONSTRATION

-- End of Section Table of Contents --

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SECTION 15627

RECIPROCATING WATER CHILLERS
12/03

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers water cooled reciprocating water chillers for refrigerating and air conditioning applications.

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PART 1 GENERAL

1.1 REFERENCES

****

NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

****

The publications listed below form a part of this section to the extent referenced:

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 550/590	(1998) Water-Chilling Packages Using the Vapor Compression Cycle

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-05	(1999) Handbook, HVAC Applications (SI Edition)
ASHRAE-06	(1997) Handbook, HVAC Systems and Equipment (IP Edition)
ASHRAE-Hdbk SE-SI	(2000) Handbook, HVAC Systems and

Equipment (SI Edition)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(1986e) Mechanical Vibration - Balance Quality Requirements of Rigid Rotors - Part 1: Determination of Permissible Residual Unbalance

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CE-6	(2000) How to Buy an Energy-Efficient Air-Cooled Electric Chiller

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

****

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Connection diagrams shall be submitted indicating the relations and connections of the following items. The drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Compressor
Motor
Control Panel
Condenser
Evaporator
Refrigerant Circuit
Alarm Systems
Vibration Isolators

Gages

Control Diagrams shall be submitted for water-cooled reciprocating chiller units in accordance with paragraph entitled, "Control," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted for the following items indicating use life, system functional flows, safety features, and other features such as electrical system protective device ratings.

Chiller Unit
Compressor
Condenser

Manufacturer's catalog data shall be submitted for the following items:

Accessories
Spare Parts
Vibration Isolators

SD-07 Certificates

Certificates shall be submitted for following items showing conformance with the referenced standards contained in this section.

Compressor
Motor
Control Panel
Condenser
Evaporator
Refrigerant Circuit
Alarm Systems
Vibration Isolators
Gages

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for water-cooled reciprocating chiller units in accordance with paragraph entitled, "General Requirements," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Manufacturer's Field Service," of this section.

1.3 GENERAL REQUIREMENTS

Manufacturer's Instructions shall be submitted for water-cooled reciprocating chiller units including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

1.3.1 Mechanical

****

NOTE: If Section 15003 GENERAL MECHANICAL PROVISIONS is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted. If Section 15072 VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT is not included in the project specification, applicable requirements therefrom should be inserted and the second paragraph deleted.

****

[Section 15003 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.]

[Section 15072 VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT applies to work specified in this section.]

1.3.2 Electrical

Motors shall be rated in accordance with Section 16225 MOTORS.

Solid state sensors and protection shall be in accordance with Section 16286 OVERCURRENT PROTECTIVE DEVICES.

PART 2 PRODUCTS

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NOTE: Compressor and motor balance shall conform to ISO Std. 1940/1 - (1986) Balance Quality Requirements of Rigid Rotors - Determination of Permissible Residual Unbalance unless otherwise noted. Motor vibration levels shall conform to NEMA Specification MG-1, Motors and Generators, Part 7 unless otherwise noted.

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2.1 MANUFACTURED CHILLER UNIT

****

NOTE: For descriptive specification, edit this article to suit project conditions. If performance specification is used for the project, delete this article.

****

Provide factory assembled water cooled liquid chiller unit, consisting of [two] [_____] [semi-] hermetic reciprocating, motor-driven compressor[s] mounted on [spring] [_____] vibration isolators, [hot gas muffler,] condenser, insulated evaporator, [independent refrigerant circuits,] thermal expansion valves, refrigeration accessories, and control panels.

Except as specified, unit and spare parts shall be the manufacturer's standard product, designed for the service indicated, and shall be tested and rated in accordance with ARI 550/590.

Unit shall be factory run-tested prior to shipment, with capacity, current draw, and control operation monitored, recorded, and submitted. Unit shall ship with a full operating charge of [R-22] or other suitable refrigerant with ODP=0.0, and oil. Unit shall operate with [230] [208] [480] volt 3-phase, 60 Hertz power.

"Energy efficiency ratings shall meet or exceed the full-load efficiency and the integrated part-load value (IPLV) efficiency ratings as described in ARI Standard 550/590-98 and DOE CE-6."

2.2 LIQUID CHILLER

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NOTE: Performance specification for one, or identical units. Use schedule to specify units of different sizes.
****

Reciprocating water chiller unit shall have minimum capacity of [_____] tons of refrigeration watt when delivering [_____] gpm cubic meter per second of chilled water at [_____] degrees F degrees C when supplied with [_____] gpm cubic meter per second of condenser water at [_____] degrees F degrees C. For determining this capacity, the fouling factor for evaporator and condenser shall be no less than 0.0005. Water head loss shall not exceed [_____] feet millimeter through condenser, or [_____] feet millimeter through evaporator.

2.3 COMPONENTS

****
NOTE: The following article may be deleted, or edited as necessary to suit project conditions and to further describe the Manufactured Chiller Unit.
****

2.3.1 Compressor

Compressor(s) shall be constructed with heat treated [forged steel] [ductile iron] crankshafts, aluminum alloy connecting rods, cast aluminum pistons fitted with one compression ring and one oil ring, replaceable cylinder liners, and double mesh suction inlet screens. Housing, cylinder heads, liners, and handhole covers shall be close grain cast iron. Suction and discharge valves shall be high strength, non-flexing, ring type. Valve

plates shall be of cast iron, with ground and lapped seats. Rotating parts shall be statically and dynamically balanced to ISO 1940-1-1986, [G16] [G6.3] [_____]. Mount compressors on [spring] [_____] vibration isolators. Provide isolation service valves on inlet and outlet lines of each compressor.

2.3.1.1 Lubricating System

Provide lubricating system with positive displacement oil pump, oil charging valve, oil level sight glass, oil filter, and magnetic-plug on strainer, arranged to be self relieving to the suction side, and to ensure adequate lubrication during starting, stopping, and normal operation.

2.3.1.2 Capacity-Reduction

Provide automatic capacity-reduction equipment consisting of suction valve unloaders. Lifting mechanism shall be operated by [oil pressure] [gas discharge pressure] [solenoid valve]. Provide for unloaded compressor start.

2.3.1.3 Motor

Compressor shall conform to NEMA MG 1, be direct-driven by [1800] [3600] rpm, [230] [_____] volt, 3-phase, 60 Hertz, constant speed motor, UL listed, and designed for [across-the-line] [part-winding] [_____] starting. Motor shall have copper windings and be suction gas cooled. Solid state sensor and electronic winding overheating protection shall be provided.

2.3.1.4 Crankcase Heater

Crankcase heater shall be immersible type. Energize heater [continuously] [_____]. [Mount a "DANGER - EXTERNAL POWER SUPPLY" sign having 3/8-inch 10 millimeter white letters with red background on the junction box for the crankcase heater.]

2.3.2 Condenser

Condenser shall be shell-and-tube type, of [seamless] [welded] steel construction, with removable [cast iron] [fabricated steel] heads [and independent, dual refrigerant circuits].

Tubes shall be cleanable [and] [replaceable] [seamless copper] [_____], with integral fins, [expanded] [_____] into tube sheets.

Design, test, and stamp refrigerant side for [300] psig [2050] kilopascal [_____] working pressure in accordance with ASHRAE-06, Chapter 13 ASHRAE-05 and ASHRAE-Hdbk SE-SI.

Provide [300] psig [2050] kilopascal [_____] safety relief valve on condenser shell.

Design, test, and stamp water side for [150] psig [1030] kilopascal [_____] working pressure in accordance with ASHRAE-06, Chapter 13 ASHRAE-05 and ASHRAE-Hdbk SE-SI. Provide drain connection.

2.3.3 Evaporator

Evaporator shall be shell-and-tube type, of [seamless] [welded] steel construction, with removable [cast iron] [fabricated steel] heads [and independent, dual refrigerant circuits].

Tubes shall be cleanable [and] [replaceable] [seamless copper] [_____], with integral fins, [expanded] [_____] into tube sheets.

Design, test, and stamp refrigerant side for [225] psig [1550] kilopascal [_____] working pressure, and water side for [150] psig [1030] kilopascal [_____] working pressure, in accordance with ASHRAE-06, Chapter 13 ASHRAE-05 and ASHRAE-Hdbk SE-SI. Provide water drain connection.

Insulate with [_____] [100] inch [25] millimeter thick flexible [expanded polyvinyl chloride] [polyurethane foam] insulation with maximum K value of [0.26] Btu per hour per foot square per degree F [0.037] watt per meter per degree Kelvin [_____].

2.4 ACCESSORIES

2.4.1 Refrigerant Circuit

Each independent refrigerant circuit shall be factory supplied and piped, and complete with liquid line solenoid valve, filter dryer, liquid line sight glass and moisture indicator, thermal expansion valve, [charging valve] [1/4-inch 8 millimeter flare charging ports], insulated suction line, compressor discharge service valve, [discharge line check valve.]

2.4.2 Control

Control Diagrams shall be submitted for water-cooled reciprocating chiller units showing the physical and functional relationship of equipment. Electrical diagrams shall show size, type, and capacity of the systems.

Power and control devices, including but not limited to motor starters, relays, timers, fuses, circuit breakers, shall be in accordance with Section 16286 OVERCURRENT PROTECTIVE DEVICES.

Components of the control panel, and external control devices, shall be UL listed. All components shall be designated with a code, and called out by that code on the wiring diagrams and schematics.

Timers shall be electronic, with adjustable settings. Indicating lights shall be push-to-test type and easily replaceable from the front of the panel.

2.4.2.1 Sequence Panel

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NOTE: Include this paragraph only if multiple units are provided.
****

Provide a [remote mounted] sequence panel, with sequence switch, temperature controller, and low temperature cutout, to permit operation in [series] [parallel] with lead-lag switching.

2.4.2.2 Control Panel

Control panel, having separate sections for starter and refrigeration controls, shall be furnished for each compressor and located [on] [near] chiller unit. Starter section shall have internal access door and customer connection junction box with knockouts for remote interlocks.

Control panels shall be factory assembled, and shall be wired in accordance with UL and NFPA 70 requirements, with single point power connection. Each wire shall be identified at every termination with a wire number matching the wiring diagram and control schematic. Wire identification shall utilize preprinted heat-shrink wire sleeves. Hand lettering or marking is not acceptable.

For each control panel, the starter section shall have:

Circuit breaker type combination starter.

Power controls for [across-the-line] [part winding] [_____] starting.

Control power [fuse] [circuit breaker].

Control power transformer for [115] [_____]-volt control voltage.

Terminal blocks, having terminals for the main power supply and all auxiliary connections clearly identified.

Pumpdown control relay.

Compressor starter relay.

Reset relay.

Non-recycling compressor overload relay.

Anti-recycle timer.

For each control panel, the refrigeration section shall have:

High pressure control.

Low pressure control.

Motor protection.

Oil pressure control.

The following devices shall be mounted on the control panel face:

Compressor run lights.

System start-stop switch.

Hand, Off, Auto switch.

[Suction and Discharge Pressure Gages.]

[Compressor lead-lag switch.]

Demand limit switch.

2.4.2.3 Operating Controls

Provide the following operating controls:

[Multi] [_____]-step capacity control in response to [leaving] [return] chilled water temperature.

Five minute off timer to prevent short cycling.

[Part-winding start timer.]

Periodic pump-out timer, to pump down on chilled water flow and high evaporator refrigerant pressure.

Load limit thermostat to limit compressor loading on high return chilled water temperature.

Three phase monitor to protect unit by stopping compressor on phase loss, phase reversal, phase unbalance, or under voltage.

Cycle counter and operating hour meter.

Computer switching circuit.

2.4.3 Alarm Package

An alarm package for alarm systems with test button shall be furnished. Lights shall be furnished to indicate when control circuit is energized and compressors are running. An audible alarm and indicating lights shall be provided to indicate compressor malfunction, low chilled water temperature, and evaporator water flow failure.

2.4.4 Hot Gas Bypass

Provide hot gas bypass valve, and associated control panel wiring and piping, to allow operation of unit below the minimum step of unloading.

2.4.5 Gage Board

Provide factory piped gage-board for each compressor, with pressure gages for suction and discharge refrigerant pressures, and oil pressures.

2.4.6 Vibration Isolators

Provide vibration isolators as recommended by the manufacturer to support complete chiller unit. Refer to Section 15072 VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT for vibration isolation considerations.

PART 3 EXECUTION

3.1 INSTALLATION

Install chiller assembly in accordance with manufacturer's instructions. [Provide connection for electrical service.]

Provide connections for chilled water piping, condenser water piping, and auxiliary water piping. [Arrange piping for easy dismantling to permit tube cleaning.] Provide piping from safety relief valve to outdoors.

Chilled water inlet piping shall have [thermometer,] [strainer,] [flow switch,] [flexible pipe connector,] [pressure gage,] [and] shut-off valve.

Chilled water outlet piping shall have [flexible pipe connector,] [thermometer,] [pressure gage,] [and] [shut-off] [balancing] valve.

Condenser inlet piping shall have [thermometer,] [strainer,] [flow switch,] [flexible pipe connector,] [pressure gage,] [and] shut-off valve.

Condenser outlet piping shall have [flexible pipe connector,] [thermometer,] [pressure gage,] [and] [shut-off] [balancing] valve.

3.2 MANUFACTURER'S FIELD SERVICE

Contractor shall submit [6] [_____] copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the water-cooled reciprocating water chiller units. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

Service of factory trained representative shall be furnished for a period of [_____] calendar days, to conduct training and supervise [dehydration and charging,] testing, and start-up.

3.3 DEMONSTRATION

Demonstrate system operations and verify specified performance.

-- End of Section --